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ABSTRACT

Seventy-two children, 18 from each of grades three, six, nine, and twelve, participated in a study of developmental changes in children's knowledge about the morphological structures underlying the spoken form of complex derived words. Three oral language tests were used to show when and how children learn that derived words are not unanalyzable wholes but, rather, can be derived by regular phonological rules, from underlying (base) morphemic constituents. Two standardized reading tests and two experimenter-designed oral reading tests were used to investigate the relationships between knowledge of derived-word formation processes and reading. The oral language tests showed differences in the phonological competence of children between the ages of 8 and 17; these differences were related to children's performance on specific reading tasks. (Author/AA)

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RELATIONS BETWEEN LEXICAL DEVELOPMENTAL CHANGES AFTER AGE 7 AND READING.

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CS 003 564

Rosemarie Myerson

Relations Between Lexical Developmental Changes After Age 7 and Reading[1]

At the age when children are learning to read, important changes are still occurring in the underlying structures that they use for processing the words of their spoken language. Recent linguistic theory distinguishes between speech performance behavior and the inner mental processes underlying the speech act. It also provides us with an abstract model of the adult speaker's inner language code by describing this code in terms of the base units and the system of rules that the mature speaker uses for transforming basic ideas into this actual spoken form. Psycholinguistic research tests the adult's verbal behavior in order to verify the reality of these theoretical base units and grammatical rules. Longitudinal and/or cross sectional studies of children of different ages are needed to show the pattern of changes that occur developmentally as children acquire inner knowledge of their language's code for relating speech and meaning.

This study investigated developmental changes in the inner knowledge that children between the ages of 8 and 17 have acquired with respect to the morphological structure underlying the spoken form of complex derived words of their language. Complex derived words are those suffixed words involving systematic changes in the sounds of the base word in the derived word. For example, in the pair of words distort-distortion, the addition of the suffix -ion has changed the final [t] sound of the base verb distort into an [š] sound in the derived noun distortion. This study also investigated the relationship between inner

knowledge of complex word formation processes and the attainment of higher levels of reading.

The two purposes of this research were:

1. to question when and how children learn that derived words of their language are not unanlyzable wholes, but rather can be derived by regular rules from their underlying (base), morphemic constituents.

2. to show the nature of the relationships between the level of the child's inner knowledge of the systematic grammatical relationships between pairs of base and derived words and various aspects of reading achievement.

Statement of the Problem

Mature reading involves abstracting the author's meaning from the printed text. The variables affecting reading can be subsumed under two categories:

1. those factors inherent in the nature of the written text

2. those factors due to the nature of the processor, i.e. the reader of that text.

Readability measures for material above third grade level show that the most potent factor determining the difficulty of a written text is vocabulary. Measures of the familiarity of the words and/or measures of the number of affixes or syllables are the best predictors of text difficulties (Dale and Chall 1948). Indeed Shankweiler and Liberman (1972) show that even at the beginning stage of reading the primary locus for reading difficulties is the word. Loban's longitudinal study (1963) shows regular correlations between reading achievement and vocabulary throughout the primary grades. R. Thorndike (1973) shows that for the

mature reader, tests of word knowledge and tests of paragraph comprehension achievement are both assessing the subject's verbal reasoning. Studies of dyslexic children (Naidoo, 1972; Mattis etc. 1973) show an early maturational lag in different aspects of the dyslexic readers use of the words of his language.

Recent psycholinguistic studies have focused on describing developmental changes in specific aspects of the inner language code of children over the age of four; reading research has used such studies to question the relationship between linguistic maturity and reading achievement. Berko (1961) showed that children between the ages of 4-6 are in the process of mastering the English code for inflecting regular nouns for plural and verbs for tense. Brittain (1970) used Berko's test of grammatical inflectional knowledge with first and second grade children and found correlations between beginning reading achievement and the level of knowledge of English grammatical inflectional rules. The word association studies of Entwistle (1967) and of Anglin (1970) show that from age 7 through adolescence there occurs a reorganization of semantic aspects of the lexicon. C. Chomsky (1969, 1970, 1971) tested the knowledge of children of ages 6-10 with respect to English verb complement constructions and showed correlations between the level of inner knowledge of English verb complement constructions and reading. Vogel (1975) adapted the linguistic tests of Berko, C. Chomsky, and of others and found deficits in the syntactic ability of dyslexic children of ages 7 and 8. Pike (1976) tested the ability of good and poor readers of ages 11 and 12 to appreciate the syntactic and semantic regularities of different types of strings of words that were presented to them auditorally for oral recall. Her study showed that the ability to make use of

syntactic and semantic knowledge in processing oral language correlated with reading achievement. Thus, there is evidence that developmental changes in different facets of a child's inner code for processing oral language continue to occur through adolescence and that the level of maturity of the child's oral language code is a factor correlated with reading achievement.

The written code for representing complex derived words is abstract in relation to the spoken sounds. In Sound Pattern of English (SPE) (1968), Chomsky and Halle show that the orthographic code requires considerable phonological sophistication of the reader. The written code tends to preserve morphemic identity; i.e., it has one visual representation for one meaningful unit. Because English orthography is basically morphemic, those sound changes that are predictable by general rule of speech are not given visual representation. For example, in the pair of words distort-distortion, there is no change in the visual representation of the base word despite the fact that the addition of the suffix -ion caused the final [t] sound of the base to be changed to an [š] sound in the complex derived word distortion. Such sound changes between base and derived words are predictable; whenever -ion is suffixed onto a base verb, the final consonant of the base becomes palatalized in the derived noun. SPE hypothesizes that knowledge of the pattern of sound changes between specific types of base and derived words is part of the adult English speaker's phonological competence. The phonological rules in SPE require that the speaker have internalized a representation of the morphemes of his spoken words that is abstract in relation to the phonetic (spoken) form of the word.

Novel derived words like cran-orange juice or chickenburger show that adults know how not only to pronounce but also to assign meaning to newly encountered derived words formed with neutral (nonsound changing) word derivational suffixes. The adult's language processing mechanism enables him to recognize the underlying morphemic structures of such words and to use etymological cues for deriving meaning. Aronoff (1974), using SPE phonological rules, described the processes by which base words of a specific syntactic category are transformed into derived words of another syntactic category. Aronoff found that word derivational rules can only be described in terms of the morphological structure of subsets of base words. He shows that English word formation processes are such that the syntactic label, the pattern of sound changes, and a semantic reading for the derived word are predictable from the morphological constituents.

Evidence that speakers of the language acquire inner knowledge of word formation processes should have important implications for reading because it is this base morphemic structure rather than the phonetic (spoken) realizations that is represented in the written form. This study addressed the question of the psychological reality of SPE's hypothesized abstract forms and phonological rules for deriving the spoken form of complex derived words by testing children for inner knowledge of the regular phonological processes relating certain base and complex derived word pairs. The study questioned whether children ever learn that distort bears the same systematic relation to distortion that relate bears to relation and, also, how does such knowledge relate to different stages of reading.

Prior Research on Knowledge of Word Formation Processes

The prior research on inner knowledge that either children or adults have about English complex word formation processes is not consistent. The results that a researcher drew from his data were dependent upon the nature of the task that was required of the subjects. Testing for inner knowledge of grammatical inflections, Anisfeld and Tucker (1973) show that subjects have alternative strategies for solving different language types of language tasks. The work of Robinson (1967) and Steinberg (1973) questioned inner knowledge of word formation processes. Both these researchers used tasks that required that the subject produce by creating and saying aloud new derived words. With this type of task, even college students failed to consistently apply the required pattern of sound changes. However, studies of word suffixing ability that presented different kinds of task to the subjects show certain knowledge of such sound pattern changes. Using an associative learning task for investigating the knowledge that children had about English tense-lax vowel shift relations, Moskowitz (1973) found that children between the ages of seven and twelve had inner knowledge of [iy] ~ [ɛ] and [ɛy] ~ [æ] vowel shift sound changes before the suffix -ity. Since the age of the children who showed inner knowledge of vowel shift alternations was such that all had also been exposed to the written language, and since Read's (1971) work with younger children's spontaneous writings had shown no knowledge of English tense-lax vowel shift pairings, Moskowitz concluded that the source of her children's vowel shift phonological knowledge was the English spelling system.

Ladefoged and Fromkin (1967) showed that adults attending a lecture on linguistics could correctly mark the pronunciation of nonce suffixed words which had been printed in sentences. From this evidence, Ladefoged and Fromkin concluded that adults know the systematic sound pattern relationships between base and complex derived word pairs. Neither of these studies questioned the relationship between knowledge of the systematic relations between base and derived word pairs and reading achievement. Moskowitz's and Ladefoged and Fromkin's studies show that tasks which do not require that a subject create and say novel suffixed words can show certain knowledge of complex word formation sound patterns. In order to investigate developmental changes in the lexical processes that children between the ages of 8 and 17 have internalized for processing complex derived words, this study created a new experimental method which uses long-term memory for showing evidence of the inner grammatical code. Children were taught new derived words and then tested for their ability to remember the phonological pattern of these words over a 6-week period.

Design of the Study

The selection of the five sound patterns

Testing only for knowledge of vowel shift before -ity, Moskowitz (1973) found that changes in children's abstractions about English tense-lax vowel pairs occurred at the same age as when children learn to read and to write. In order to test Moskowitz's hypothesis that the spelling system was the source of children's knowledge of English vowel shift sound pattern relations, this study investigated children's acquisition of inner knowledge of sound patterns that are and are not part of the

orthographic code. Of the five sound patterns selected for this study, three are patterns that are abstractly encoded in the English writing system and two are sound changes that are not given any visual representation. Below are listed the five sound patterns used and a discussion of the relationships between the orthographic representation and the sound pattern: (-ion, -ity, and -ical are the three suffixes used).

1. Palatalization before -ion as in relate-relation or distort-distortion. Whenever the suffix -ion is added onto a base verb, the final consonant of the base is changed to a palatalized sound. Palatalization is abstractly encoded orthographically, for one consonant letter "t" is used to represent the [t] sound of distort and the [š] sound of distortion.

2. Vowel shift before -ity as in sane-sanity or in grave-gravity. The orthographic representation of the [ey] ~ [æ] tense-lax vowel sounds in each word pair is abstract in relation to the phonetic sounds, one vowel letter, "a" represents the [ey] sound of sane and the [æ] sound of sanity.

3. Vowel shift before -ical as in meter-metrical or in gamete-gametical. As in vowel shift before -ity, the visual representation of the tense-lax vowel sounds is abstract in relation to the spoken sounds. One vowel letter, "e" represents the [iy] sound of meter and the [ɛ] sound of metrical, two sounds that acoustically (and articulatorally) are qualitatively different.

4. Stress shift before -ity as in moral-morality or in human-humanity.

5. Stress shift before -ical as in history-historical or in method-methodical.

In contrast to the abstract written representation of palatalization sound changes and of tense-lax vowel shift sound changes, stress placement is never marked in the writing system. The written language does not formally give the child any visual encoding of the English pattern of stress shift rules. Therefore while at the beginning stages of learning to read and to write, children are taught that the letter "a" represents [ɛɣ] and [æ] sounds and that the letter "e" represents [iɣ] and [ɛ] sounds, they are not formally taught English stress shift sound changes as part of their reading and writing education. Thus, the spelling system cannot be the source of children s knowledge of English stress shift rules.

Tests

Three Tests of Oral Language Competence

Three types of oral language tasks were given to the 72 children in order that the results from the experimentor created Word Recall Test could be compared to data from two traditional tests of linguistic knowledge. All three oral language tests used nonce words whose sound patterns and meanings were modeled on real words. Each nonce word was verbally defined and accompanied by a picture. All verbal contexts were such that the syntactic category of the derived word was clear. Each of the three tests had ten items, two for each of the five sound patterns. In the production test, in the conscious judgment test, and in the teaching session for the derived words of the word recall test, the subjects were shown a suffix card on which was printed the suffix to be affixed to that base word. (See Appendix for details of word recall test procedure.)

1. The production test required that the child create and say novel derived words. This task was comparable to that of Robinson (1967), and Steinberg (1973).

2. The conscious judgment test asked the child to decide which of two derived words sounded better. One choice was the phonologically correct sound pattern and the second choice was incorrect because the required sound changes had not been made. The incorrectly formed derived word sounded phonetically similar to its base word. The phonetics of each incorrect choice are like those of the T type words of the word recall test (See Appendix).

3. The word recall test measured the child's ability to recall new derived words over a period of six weeks. For each of the five sound patterns, each child learned two types of nonce derived words; one of which sounded phonetically similar to its base word since the required sound changes had not been made, and the second was a word whose sound pattern differed systematically from its base nonce word according to English word derivational rules. (See Appendix for examples.) Recall I was one day after teaching, Recall II, one week later, and Recall III was 6 weeks after teaching. No suffix cards were used in recall testing.

Four Tests of Reading

Two standardized tests of reading achievement:

1. Stanford Achievement Test for third graders and STEP for the children in the upper grades measured silent paragraph comprehension performance.

2. WRAT test measured oral word list reading ability.

Two experimental tests for measuring oral reading ability with real complex derived words were created:

1. The Uncle John Story, a 148 word story, contained the ten real derived words whose sound-meaning patterns served as models for the nonce

words of the oral language tests. The story was of seventh-eighth grade level of reading difficulty based on the Dale and Chall formula (1948).

2. The 29 Word List, a list of derived words graded for difficulty. The list had four words representing each of the five sound patterns and nine "filler" words. The 3rd grade words were selected from the Dale list (Dale and Chall 1948). The fourth, sixth, ninth, and twelfth grade words were from the word list in Dale and Eichholtz (1960), and the Harris and Jacobson (1972) word list.

I.Q.

I.Q. was measured by Peabody Picture Vocabulary Test which gives a measure of intelligence based on comprehension of words presented orally.

Subjects

Seventy-two children, 18 from each of grades three, six, nine, and twelve were selected on the basis of their scores on standardized tests of silent reading. One-third of the children in each grade were poor readers, one-third average, and one-third were good readers. All were monolingual speakers of English attending local suburban schools; all had normal or better intelligence. The youngest children were approximately 8 years old since pilot testing showed that children much younger than 8 had great difficulty performing the word suffixing operations.

Insert Table 1 about here

Table 1

Silent Paragraph Reading Percentile Scores, WRAT Grade Equivalency Scores, and PPVT I.Q. Scores for Poor, Average, Good Readers in Grades 3, 6, 9, 12

	Paragraph Compr. Percentile		WRAT grade equiv.		PPVT I.Q.	
3rd grade	$\bar{X}$	St. Dev.	$\bar{X}$	St. Dev.	$\bar{X}$	St. Dev.
poor	23.0	21.7	3.2	0.8	102.0	11.8
average	83.5	6.7	4.9	1.0	112.2	14.0
good	93.8	1.0	5.6	0.6	114.1	11.0
6th grade						
poor	33.7	11.8	6.6	0.6	109.0	17.3
average	60.5	12.3	7.3	1.3	109.8	11.8
good	93.5	6.2	9.5	1.0	122.2	8.0
9th grade						
poor	57.2	10.8	8.7	1.0	102.7	8.9
average	81.8	5.4	9.5	1.4	105.5	9.9
good	92.7	4.3	11.2	1.7	122.8	16.3
12th grade						
poor	35.3	9.2	10.0	1.9	95.7	5.6
average	62.7	5.1	11.6	1.7	115.2	9.7
good	87.0	7.7	13.3	1.8	115.5	13.3

RESULTS

A Comparison of the Three Oral Language Tests of Competency With Respect to Complex Derived Words

A brief summary of the results of the three oral language tests is presented in order to show why the results of the long term word recall tests were used as evidence of the inner structures that children have acquired for processing complex derived words. There were three tests of oral language competency administered and there were dramatic differences between the three oral language tests in respect to the number of correct responses in each grade for each sound pattern. Of the three oral language tests of inner knowledge of complex word formation processes, the word recall task was shown to be the most sensitive indicator of the children's inner lexical knowledge. For a detailed analysis of the results from each of the three oral language tests see Myerson 1976, 1977.

The production and conscious judgment tasks, the two traditional tests of linguistic knowledge, as well as the word recall tests, the newly created experimental method for testing inner language code, all showed that a child's performance depended upon the sound pattern. However, for different reasons, the production and the conscious judgment tasks were poor tests for showing the deep structure generalizations that children have for forming complex derived words. With respect to the production tests, comparatively few correct responses were obtained for each of the five sound patterns. Children who made one or two correct choices on a conscious judgment test of a sound pattern often failed to make any changes in the sounds when they created a new derived word of that sound pattern in the production task. Only for palatalization before -ion did

the Chi Square test show a significant measure of association between the 72 subjects' performance on the production and the conscious judgment tasks. This association resulted because almost all the subjects knew palatalization -ion.

The conscious judgment test produced uneven developmental trends due to the complex mental analogical processes required for making the correct choice. For palatalization and for vowel shift derived words, the English language code is such that both the T and the L type words are sound sequences acceptable for an English word. Therefore, deciding whether the T or the L choice was the correct derived word required that the subject compare the sounds of each of the derived words with those of the base word; a child could not make the correct decision solely on the basis of the acceptability of the sound sequence in the derived word. This decision making process on the conscious judgment palatalization and vowel shift words was especially difficult for some of the 8 year old children.

Word Recall Test Results

The word recall test was a difficult one. The word recall data from all five sound patterns combined, shows that in each grade the 18 children were always more accurate in recalling the five phonologically correct L words than the five incorrect type words. With respect to the overall performance with the two word for each of the five sound patterns, only one subject, a ninth grade good reader, was able to correctly recall all ten derived words as taught. The mean number of words correctly recalled rose from third to ninth grade. There was also an increase in overall recall accuracy from Recall I to Recall III for all grades.

Nevertheless, at the six week recall session (Recall III), the mean number of words correctly recalled as taught by 3rd graders was only 2.9; for sixth graders, it was 4.1; for ninth graders, 6.1; and for twelfth graders, 5.9 words.

Relation Between Overall Word Recall Accuracy and Reading Grouping

What was the relationship between reading level and recall ability for the ten derived words? Within each grade, the mean number of derived words correctly recalled by the poor readers in each grade at Recall III was always less than that of the good readers of that grade. Also the change over the three recall sessions in the mean number of derived words correctly recalled by the three reading groups of each grade showed that poor readers improved less than did average or good readers. This shows that for each grade, the poor readers' inner word formation knowledge and memory trace of the original words was such that they did not improve in the same way as did the better readers with the passing of time and repeated testing.

The third graders showed the greatest variability in the total number of words correctly recalled in relation to their reading abilities. Poor third grade readers at Recall III correctly recalled only 1.8 of the ten words that they had been taught; average reading third graders recalled correctly 2.5 words; and the good third grade readers' Recall III mean accuracy was 4.3 words. A repeated measures three way analysis of variance on the number of derived words correctly recalled by each reading group in each grade showed significant grade effects ($F_{3,60} = 16.46$, $p < .001$), significant reading group effects ($F_{2,60} = 3.89$, $p < .05$), significant recall effects ($F_{2,120} = 17.01$, $p < .001$), and nonsignificant interaction

effects. Tukey's test showed that all three third grade reading groups differed significantly in respect to the number of derived words that they correctly recalled at Recall III. While the poor and average sixth grade readers did not differ significantly, both groups performed significantly poorer than did the good sixth grade readers in respect to the number of derived words correctly recalled at Recall III. There were nonsignificant differences between the three reading groups of ninth and twelfth graders with respect to the number of derived words correctly recalled at Recall III.

Relation Between Word Recall Accuracy For Each of the Five Sound Patterns and Grade and Reading Group Within Grade Results

The ten derived words of the word recall test questioned knowledge of five different sound patterns. The word recall data showed that with increase in grade, there was an overall improvement in the mean number of words recalled as taught. However, this improvement differed for each sound pattern. The responses of the 18 subjects in each of the four grades to the two types of words for each sound pattern (the phonologically correct L word and the phonetically similar T word) were compared on the basis of four possible categories of responses:

-T +T -T +T
-L -L +L +L

-means the word was not recalled as taught and + means that the subject correctly recalled that particular T or L word as it had been taught to him.

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Insert Table 2 about here

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Table 2

Cross Tabulations of Responses of 18 Subjects in Each of Four Grades according to 4 Categories of Responses for Each Pair of L and T Words of Each Sound Pattern

Palatalization+ion

grade	-L -T	-L +T	+L -T	+L +T
3	2		16	
6	2		14	2
9			14	4
12			14	4

χ^2 = 8.607, not sign.

Vowel Shift +ity

grade	-L -T	-L +T	+L -T	+L +T
3	10	1	5	2
6	4	1	11	2
9	1	2	10	5
12	3	1	6	8

χ^2 = 19.673* p < .05

Vowel Shift +ical

grade	-L -T	-L +T	+L -T	+L +T
3	12	2	4	
6	9	2	7	
9	5	3	4	6
12	5	1	9	3

χ^2 = 19.484*, p <.05

Stress Shift +ity

grade	-L -T	-L +T	+L -T	+L +T
3	7	8	3	
6	7	3	6	2
9	1	3	10	4
12	1		14	3

χ^2=30.651***, p < .001

Stress Shift +ical

grade	-L -T	-L +T	+L -T	+L +T
3	10	5	2	1
6	6	5	1	6
9	1	1	7	9
12	2		7	9

χ^2 = 32.305***, p < .001

The cross tabulation data for the subjects on the Recall III performance for each of the five sound patterns is in Table 2. Chi Square tests of independence of grade and category of response showed significant grade differences for all the sound patterns except palatalization of dentals -ion. There were nonsignificant differences between grade and category of response for palatalization because this sound pattern was known by almost all the 72 subjects. Only the two poorest third grade readers failed to correctly recall the L palatalization word at Recall III; all the other subjects showed inner knowledge of the sound change before the suffix -ion by correctly recalling the L palatalization word.

On vowel shift -ity, the sixth graders performed significantly better than did the third graders. Sixth graders were 72% correct in their recall of the L vowel shift -ity word at Recall III in contrast to the 39% correct for third graders. Furthermore, Chi Square tests comparing the reading groupings within grade responses to the L and T vowel shift -ity words, showed that the three third grade reading groups differed significantly in respect to their responses on vowel shift -ity, $p < .05$, with mainly the good third grade readers showing the ability to correctly recall the phonologically correct L vowel shift -ity words at Recall III.

Over the four grades, there was a regular improvement on vowel shift -ical. Even at 12th grade, the curve representing the percent of children knowing vowel shift -ical had not asymptoted. At third grade, only 22% of the children correctly recalled the L vowel shift -ical word; sixth graders were only 39% correct at Recall III; it was not until ninth grade that 50% of the subjects were correctly recalling at Recall III the

phonologically correct L vowel shift -ical word. Even at 12th grade only two-thirds of the children showed inner knowledge of this sound pattern. Chi Square tests of reading grouping within grade showed only nonsignificant difference between reading grouping and responses on the vowel shift -ical words for each grade.

On both stress shift -ity and stress shift -ical, it was again not until ninth grade that over 50% of the subjects were able to correctly recall the phonologically correct L word at Recall III. While only 17% of the third graders correctly recalled the L stress shift -ity word at Recall III, another 44% showed knowledge of the -ity suffix by correctly recalling the T word. On stress shift -ical while the third graders were 17% correct on the L word, less than 27% were correct on the T vowel shift -ical word showing that while the majority of third graders knew the suffix -ity, most third graders did not know the suffix -ical. Sixth graders tested better than third graders on both the stress shift words; by ninth grade, 78% of the children were able to correctly recall the L stress shift -ity word at Recall III, and 89% were correct on the L stress shift -ical word. Chi Square tests of the category of response to the L and T words for each of the stress shift sound patterns by reading groupings within grade showed that at the third grade level, there were significant differences, $p < .05$, in the three reading groups' recall response to the stress shift -ity words. Only the good third grade readers (three of the total of six) showed inner knowledge of stress shift -ity sound pattern.

Discussion

In summary, since all subjects except the two poorest third grade readers showed inner knowledge of at least one complex derived word formation process, one can state that by age 8, most children are forming inner hypotheses about the morphemic segments underlying the spoken form of complex derived words. Furthermore, the analysis of variance test of overall recall accuracy with the ten derived words showed that the poorer readers in third and sixth grades have internalized knowledge of fewer sound patterns than have the good readers in each of these grades. Furthermore, third graders had the most variability in word recall performance. In the testing, one child, the poorest reader (a third grader reading at 1.5 grade level on the Stanford Primary I) was unable to operate with the suffixing tasks; this subject was only able to give definitions at the recall test sessions. He was able only to attend to word meaning and not able to attend to the morphemic structure of the complex derived words. In striking contrast, another third grader, one of the good readers, showed inner knowledge of all five sound patterns by being able at Recall III to correctly recall all five of the L phonologically correct words. He erred on all five of the T (the incorrectly derived) words by changing each of these to the phonologically correct L sound pattern. Thus, he showed that he knew all five sound patterns and also that he was totally unaware that he had been taught two different sound patterns for each of the five types of words. His inner schema for each sound pattern was such that he was unable to learn a phonologically incorrectly derived suffixed word.

Order of Acquisition of Inner Knowledge of the 5 Sound Patterns

A Guttman scale test was performed by analyzing the number of phonologically correct L words recalled at Recall III by each of the 72 subjects (grade and reading level were ignored in this test analysis; subjects were grouped according to the number of L words that were correctly recalled). The purpose of the analysis was to see whether if one knew the number of sound patterns a subject knew, could one then predict which of the sound patterns he knew. The Guttman scale questions whether the data shows that there is a predictable order in which the subjects acquired inner knowledge of the five sound patterns.

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Insert Table 3 about here

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The Guttman scale analyses showed that both the coefficient of reproducibility and the coefficient of scaleability of the 72 subjects' L word responses were statistically significant. This means that for children between the ages of 8 and 17 (all of at least normal intelligence) independent of age, there is a predictable order for the acquisition of inner knowledge of the five sound patterns of this study. It gave the following predictable ordering:

1st acquired is knowledge of palatalization before -ion,

2nd is vowel shift before -ity,

3rd is stress shift before -ity and implied here is knowledge of stress shift -ical since the Guttman scale showed that the two stress shift patterns are not discriminable for relative order of acquisition, and

last is vowel shift -ical.

Table 3

Guttman Scale Analysis of the Accuracy at Recall III on the L Words (72 Subjects). Numbers indicate number of subjects correct for each category

Sound Patterns

	Pala talization - ion	Vowel Shift -ity	Stress Shift -ity	Vowel Shift -ical
24 children got 4 L words correct	24	24	24	24
13 children got 3 L words correct	13	11	11	4
24 children got 2 L words correct	23	13	7	5
9 children got 1 L word correct	8	1	0	0
two children got 0 L words correct	0	0	0	0

From the Guttman ordering of the sound patterns, it is evident that children acquire inner knowledge of the systematic relationships between pairs of base and complex derived words whether or not the sound changes are encoded in the spelling system. The spelling of palatalization and the vowel shift sound patterns are taught to young readers, yet the children mastered the stress shifts sound patterns, too. Therefore, it seems difficult to accept Moskowitz's hypothesis that the source of children's inner knowledge of vowel shift -ity is the English spelling system since one cannot attribute inner knowledge of the stress shift sound changes to a child's learning to read and spell. Rather, an analysis of word frequency data and of the number of words representing a specific application of a sound pattern combined with evidence from the pattern of erroneous recall responses (see Myerson 1976) imply that word frequency factors affect how and in what order the children acquired inner knowledge of particular sound patterns. Given that both Moskowitz and this researcher found that below a minimum age of seven or eight, one could not test children for generalizations about complex word formation processes and given that the acquisition of knowledge of the five sound patterns seemed related to word frequency, it seems that children's mastery of the sound patterns of English depends on maturational factors and on oral language experience. While one child knew all five sound patterns at age eight, the data showed that it was not until ninth grade that the majority of the subjects knew all five sound patterns. Further, since the percent of subjects who knew vowel shift -ical had not asymptoted even at 12th grade and since vocabulary increases throughout a person's entire life, it may be that while children first acquire inner knowledge of the systematic relationships between certain base and complex derived

words at age eight, some speakers will continue to refine their inner knowledge of particular word formation rules long after this age. There remains to be studied what factors affected the wide variation in third and sixth graders performance given that this suburban population had been selected with the expectation that it was relatively homogeneous with respect to environmental input experiences.

Results From the Two Experimental Reading Tests

Uncle John Story

Three measures of the subjects' performance on the Uncle John Story were computed: the total number of oral reading errors, the total reading time in seconds, and the total number of derived words correctly read aloud. Over the four grades, the mean number of total errors and the total oral reading time decreased regularly with increase in grade. The mean number of derived words for each sound pattern correctly read per grade increased with grade. The data for the two upper grades showed that they had most difficulty with the vowel shift -ical words. This is interesting to note since the Guttman scale analysis of the Recall III data showed that vowel shift -ical was the most difficult oral language sound pattern for the subjects to acquire.

29 Word List

The mean number of words read correctly from the 29 Word List rose regularly with increase in grade. Per grade, the list contained two complex words for each of the five sound patterns so that this test contained for each sound pattern, derived words known to children in each of the four grades. It is interesting to note that no one sound pattern gave the children more word identification difficulty than did any of those

other patterns. Thus, when one controls for word knowledge, one no longer finds any special word recognition difficulty due to the nature of the word formation process.

Within Grade Correlations Between the Standardized and the Experimental Reading Tests

Uncle John Story

Since each measure of reading of the Uncle John Story showed a similar pattern of within grade correlations to each of the standardized tests of reading, for simplicity, only the correlation coefficients based on the subjects' accuracy with the ten derived words in the story have been listed in Table 4.

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Insert Table 4 about here

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The correlations between the ability to accurately read aloud the ten derived words in the Uncle John Story and silent reading comprehension as measured by the Stanford/STEP are significant for all except grades nine and twelve with the grade twelve coefficient being very close to the chosen minimum .05 level of significance. The lower two grades have a lower correlation coefficient to the WRAT than to the Stanford/STEP, but for the upper two grades, the reverse is true; the twelfth graders' reading of the ten words in the Uncle John Story correlated at $p < .001$ with their reading of the WRAT word list. The children's reading of the derived words in the story correlated significantly with their reading of the 29 Word List only for the third graders and the twelfth graders. The Uncle John story is of seventh to eighth grade level of readability, yet the

Table 4

Within Grade Correlations Between the 10 Complex Derived Words of the Uncle John Story and the Other Reading Tests

Grades	10 Words in Uncle John Story to		
	Stanford/STEP	to WRAT	29 Word List
3	.49*	.44	.58*
6	.50*	.32	.37
9	.10	.34	.36
12	.43	.75***	.62**

*p < .05

**p < .01

***p < .001

reading of the story seems to correlate best with the other reading tests from those subjects in the two extreme grade levels, i.e. the third and of the twelfth graders.

29 Word List

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Insert Table 5 about here

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The within grade correlations between accuracy in the oral reading of the graded list of complex derived words of the 29 Word List and the Stanford/STEP paragraph comprehension and the WRAT word recognition were all highly significant ($p < .001$ for the third graders, $p < .01$ for the sixth and twelfth graders, and $p < .05$ for the ninth graders). Thus, in contrast to the Uncle John story, the 29 Word List Test seemed to be a sensitive measure of reading for all the grades in the study.

Correlations Between the Standardized Tests of Reading Achievement and Recall III

The total number of derived words correctly recalled at Recall III was shown to reflect the subject's inner knowledge of the base morphemic constituents underlying the spoken form of complex derived words; thus a subject's Recall III score is a measure of his inner knowledge of word formation processes. Table 6 gives the within grade correlations of Recall III to both the standardized and experimental reading tests.

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Insert Table 6 about here

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Table 5

Within Grade Correlations Between 29 Word List and the Other Reading Tests

Grades	29 Word List to	
	Stanford/STEP	WRAT
3	.93***	.87***
6	.61**	.66**
9	.57*	.58*
12	.47*	.68**

*p < .05
**p < .01
***p < .001

Table 6

Within Grade Correlations of Word Recall III
to the Standardized and Experimental Reading Tests

Grades	Recall III to			
	Stanford/STEP	WRAT	10 Words in Story	29 Word List
3	.59**	.52*	.62**	.67**
6	.43	.41	-.14	.55*
9	.27	.49*	.05	.09
12	.12	.37	.51*	.25

*p < .05

**p < .01

At grade three, Recall III correlated significantly with the two standardized measures of reading; for grade six, the coefficients are just below .05 level of significance. The ninth graders' Recall III scores correlated significantly with WRAT scores. Despite the fact that the analysis of variance in the Recall III data showed that by ninth grade there no longer were significant differences in inner knowledge of word formation processes in relation to reading grouping, there still was sufficient variation in the ninth graders' Recall III performance to correlate significantly with their ability to read aloud the WRAT word list. The data for the upper two grades showed a closer correlation of Recall III (the test of inner knowledge of word formation processes) to oral word recognition (WRAT) than to silent reading (STEP). This possibly reflects the fact that the higher levels of reading comprehension performance are affected not only by word recognition abilities but also by factors such as intelligence, experience, and cumulative knowledge.

Correlations Between Experimental Reading Tests and Recall III

With the two experimental reading tests, the third graders' Recall III data correlated significantly to all the measures of reading. For the third graders, inner knowledge of English word formation processes related equally to their word recognition and to paragraph processing skills. For the sixth graders, Recall III correlated significantly only with their ability to read loud the graded list of complex derived words (the 29 Word List). While their correlation coefficients to STEP and to WRAT were just shy of the .05 level of significance, there was a slightly negative correlation between Recall III and the oral reading of the ten derived words of the Uncle John Story and this will be discussed below.

Discussion

The pattern of the changes over the four grades in the correlation coefficients between Recall III and each of the two experimental tests needs to be explained. The two experimental tests tested subjects' ability to read aloud real complex derived words. Recall III correlated significantly with the subjects' oral reading of the ten real complex derived words in the context of the Uncle John Story for the third graders and for the twelfth graders (.62, $p < .01$ for the third graders and .51, $p < .05$ for the twelfth graders). The correlations between Recall III and the oral reading of the graded list of complex derived words in the 29 Word List dropped from .67, $p < .01$, for third graders, and .55, $p < .05$, for sixth graders to .09 for the ninth graders and then it rose to .25 for the twelfth graders. One could draw similar U-shaped curves to represent the pattern of changes over the four grades in the correlations of Recall III to each of the two experimental tests. How is this to be explained? The Uncle John Story tested the subjects' ability to orally read complex derived words set in a meaningful context; the 29 Word List tested oral reading ability with isolated lists of words. The analysis of variance showed that the three reading groups of third graders differed significantly in their Recall III scores; this showed that third graders' inner knowledge of word formation processes for forming complex derived words related to their silent reading comprehension skills. The significant correlations between the third graders' Recall III scores and their scores on the WRAT, the Uncle John Story, and the 29 Word List showed that their inner knowledge of the five sound patterns also related to their oral word recognition skills. For the sixth graders', their

ANOVA scores on Recall III also showed significant relations to their silent reading grouping; also the correlation coefficients show that Recall III relates significantly to their ability to orally read real complex derived words in isolated lists (the 29 Word List). Yet there was a slightly negative correlation of the sixth graders' Recall III scores and their oral reading of the real derived words in the Uncle John Story. How can one explain the fact that while sixth graders differed significantly in their inner knowledge of complex derived word formation processes and this related significantly to their word list reading, nevertheless there was no significant correlation between Recall III and their ability to read the ter derived words in the Uncle John Story? The reason must have been that, by sixth grade, the seeing of these derived words printed in a meaningful context facilitated the recognition of the complex derived words in a way that was not possible for the sixth graders when the words were printed in a list of words. This recognition of complex derived words when they are printed in a meaningful context was independent of the sixth grader's inner knowledge of word formation processes. The reason for this lack of correlation between word formation knowledge and word recognition in a story must be that certain sixth graders knew the derived words of the story as part of their oral language vocabulary. Therefore, despite their lack of inner knowledge of the general rules for forming complex derived words from their base words, these children possessed sufficient word decoding skills to enable them to recognize in print a complex derived word that they knew in their oral language.

The evidence from the correlation coefficients is that a child's spoken vocabulary facilitated word recognition in meaningful contexts in a way that was not possible in the oral reading of a list of words. Thus, for some sixth graders, the combination of letter decoding skills, oral knowledge of a word, and the presence of meaningful contextual clues resulted in their recognizing in a story words that they could not in isolation. One concludes that once

past the beginning stages of reading, children may correctly recognize in a story complex derived words that are already known to them in their spoken language and this recognition will be independent of the level of their inner knowledge of the systematic relations between the spoken form of complex derived words and the orthographic code for representing the words in print.

Within Grade Correlations of Intelligence (PPVT) to Each Measure of Reading and to Recall III

The within grade correlations of intelligence as measured by the Peabody Picture Vocabulary Tests to the various measures of reading and to Recall III are listed in Table 7.

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Insert Table 7 about here

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For each grade, intelligence correlated significantly with each of the two standardized measures of reading (Stanford/STEP and WRAT); intelligence almost always correlated significantly with the 29 Word Lists (the .46 correlation coefficient for the sixth graders is just shy of the .05 level of significance). Also, as might be expected from the analyses of the Uncle John Story as a reading test, the only significant correlation between intelligence as measured by the Peabody Picture Vocabulary Test and the oral reading of the 10 derived words in the Uncle John Story was for the twelfth graders.

Despite the significant correlations between intelligence and reading on the standardized tests, intelligence as measured by the Peabody Picture Vocabulary Test never correlated significantly with Recall III. Thus

Table 7

Within Grade Correlations of Intelligence (PPVT) to Each Measure of Reading and to Recall III

Grades	PPVT to Stanford/STEP	PPVT to WRAT	PPVT to 10 Words of Story	PPVT to 29 Word List	PPVT to Recall III
3	.56*	.68**	.42	.58*	.21
6	.55*	.67**	.20	.46	.37
9	.51*	.57*	.10	.50*	.44
12	.67**	.59**	.55*	.55*	.30

*$p < .05$

**$p < .01$

even when the measure of intelligence is based solely on a subject's oral recognition vocabulary, the data showed that inner knowledge of word formation processes never related significantly to intelligence. It must be recalled that all the subjects selected for this study were of at least normal intelligence. The Recall III test results showed that by age eight most children have inner knowledge of at least one complex word formation process; the only children not showing any awareness of the morpheme segments from which complex derived words are formed were the very poorest third grade readers. The lack of a significant correlation between Recall III and intelligence shows that most children who are eight years of age and who have at least normal intelligence have sufficient intellectual abilities do form abstractions about the systematic relationships between base and derived word pairs. Thus lexical competence never correlated significantly with intelligence while reading achievement always did. Despite these facts, the Recall III to reading correlations showed that the within grade variability in the children's acquisition of inner knowledge of the five word formation processes correlated significantly through sixth grade with their silent reading and through adolescence with their oral word recognition ability. Thus, for children between the ages of eight and adolescence who are of normal intelligence, age realted delays in the acquisition of word formation knowledge represents a factor that relates to their reading achievement independent of the level of their intelligence.

Conclusions

This study has shown that around age eight, most children with normal or better intelligence form abstractions about the morphemic segments

underlying the spoken form of complex derived words of their language. Further, at least through sixth grade, the level of a child's inner knowledge of complex word formation processes relates to his silent reading comprehension. The level of a child's word formation knowledge correlates with his oral word recognition through ninth grade. The fact that children acquire inner knowledge of the five sound patterns of this study independent of whether or not the sound pattern is abstractly encoded in the orthography and the fact that there was a predictable order by which children acquire inner knowledge of the five sound patterns and that this order was independent of orthographic encoding lead to the conclusion that the source of children's knowledge of English sound pattern relationships is not the process of learning to read and to spell. Given that the study has shown that age seven or eight is the minimum age for testing for inner knowledge of complex word formation processes, certain minimal maturational factors are imputed as being necessary for the acquisition of inner knowledge of English word formation processes. Further research is needed to explore what the factors are that underlie the variability in the age at which different children of similar cultural backgrounds master specific word formation processes.

The tests provide new information about the differences in the oral language development of children between the ages of 8 and 17 who are poor and good readers. Up to adolescence, good and poor readers differ significantly with respect to their inner knowledge of English word formation code for deriving complex derived words from base words. Further, the study shows the effect of oral vocabulary on contextual word recognition skills, especially for the child who has mastered the basic decoding level of reading.

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APPENDIX

Word Recall Test

Two versions of the word recall test were created with half of the children in each grade being taugnt each version. Version A differed from Version B in that a suffixed word that was taught in A as a T sound pattern (the incorrect sound pattern) was taught in Version B as an L word (the phonologically correct sound pattern). This controlled for any possibility that one word of a sound pattern was easier than another. A randomized order was used for teaching the ten derived nonce words.

Version A

	Base	L word	T word
Palatalization before -ion	prezate delort	prezaʃən	delorDIʒən
Vowel shift before -ity	verane trave	verɛnity	trɛvity
Vowel shift before -ical	dəreter məgeet	dərɛtrical	məgɛtical
Stress shift before -ity	túrəl rommʒl	túrality	rómm əlìty
Stress shift before -ical	gáthod néttory	gathódical	néttorìcal

Below is an example of the ritual used for teaching each of the ten derived words of the word recall test. The story was accompanied by a picture of a fishing knife and by a suffix card with -ity printed on it.

> The next word is trave. Trave means sharp. My fishing knife is sharp; it is trave. Now add "i" "t" "y" to trave to make a new word meaning sharpness. My knife is trave. I like its tr ɛvity. What do I like about my knife? I like its... my knife is sharp; I like its....

The child was to say the derived word as taught in each pause. This story ritual for the nonce derived words was reviewed two times during the teaching procedure.

At each recall session, the child heard the same story and saw the same pictures as at the teaching session, but he was not shown the suffix card. Thus, the story ritual provided him with the base word and its meaning. The recall task differed from the production task because the child had to provide the suffix as he recreated the derived word. Recall performance showed the relative ease with which a child recalled words of different phonological patterns.

There were two types of recall errors that elicited special teaching at Recall I and at Recall II. Such special teaching never changed the subject's recall score for that session, but it did give him specific information that he might be able to use at a later recall session to help in a more successful reconstruction of the correct derived word. The first type of subject error that elicited special examiner help was due to a subject's shortening a multisyllabic base word to a monosyllable in the derived word. This apocopation error was found with the stress shift words. By shortening the base to one syllable, the subject was able to retain in the derived word only that syllable which, in the base word, had been stressed. He avoided the problem of shifting stress. For example, given gáthod, as the base word, the subject who gave gáthical as the derived word provided the examiner with no evidence as to whether or not he knew the stress shift rule. His response was correct in that the stress was on the syllable before the suffix, but he had not derived the word correctly from its base word, gathod. Whenever a child made a gáthical type recall error, he was told that he had used the correct

ending, but was asked if he could keep more of the base word in making the new word. Not all subjects were able to become aware that they were shortening the base word to a monosyllable in making their derived word. Giving this extra help at an earlier recall session allowed the later recall responses of those subjects who knew the suffix but not the correct stress shift rule to be distinguishable from those subjects who knew the suffix and the correct stress shift rule. Those who knew only the suffix would give, at a later recall session, either a gathical or a T type response while those who knew the word formation rules were able to give the phonologically correct L sound pattern.

The second type of error that elicited special teaching at Recall I and Recall II was a subject's failure to use the suffix that had been used in the teaching session. For example, if a subject used -ty instead of -ity in forming the derived word, one cannot know whether or not he knows vowel shift before -ity. Therefore, after testing recall for all ten words, the examiner showed the child a suffix card for any word which had not been formed with the required suffix. The child made a new derived word using the correct suffix, and this was scored separately. This special teaching was to help subjects to use the required suffix at the next recall session.